**Supplementary Information for**

**“Non-linear response of glacier melting to Holocene warming in Svalbard recorded by sedimentary iron (oxyhydr)oxides”**

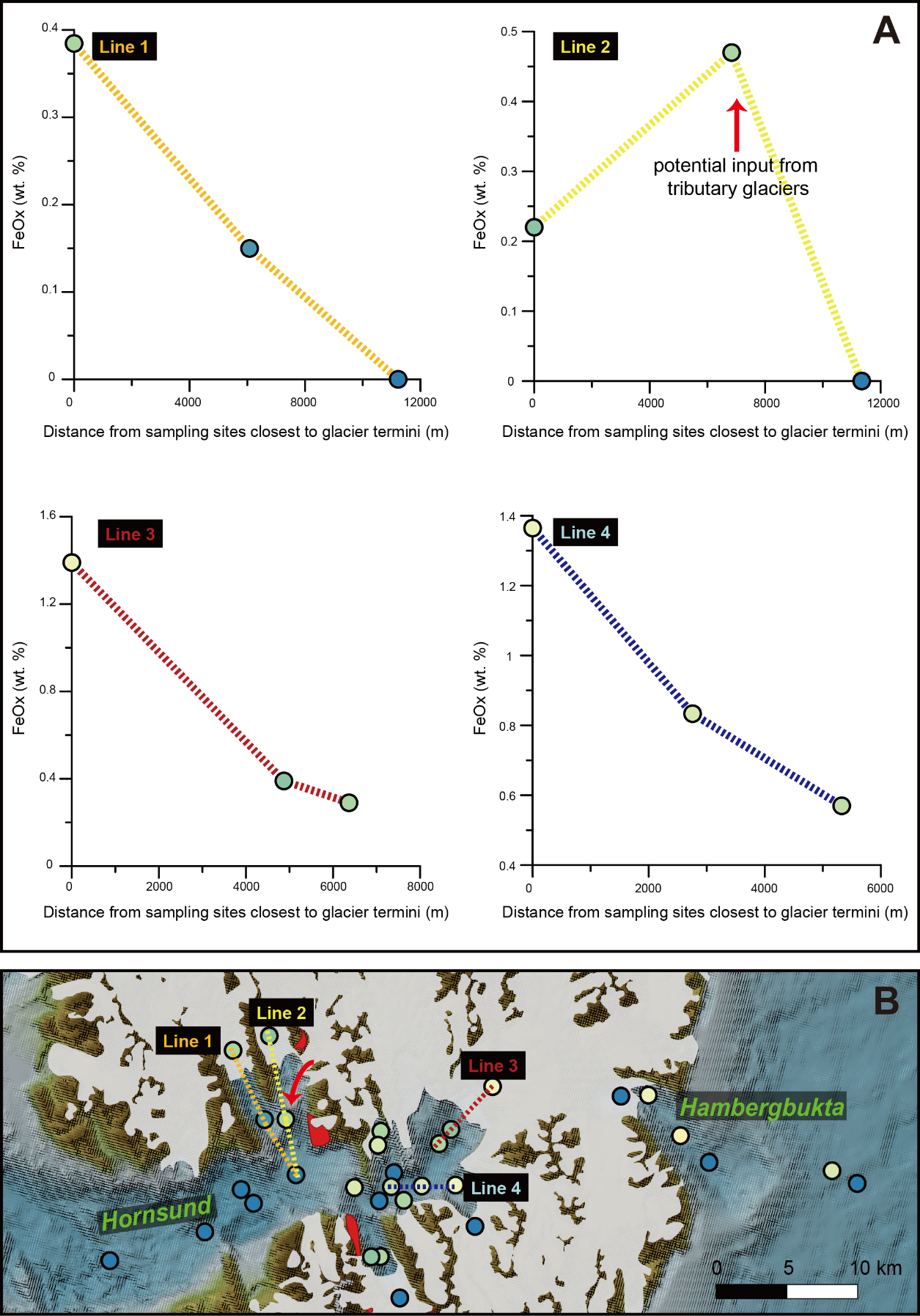
Kwangchul Janga, Germain Bayonb, Christoph Vogtc, Matthias Forwickd, Youngkyu Ahna, Jung-Hyun Kima and Seung-Il Nama,\*

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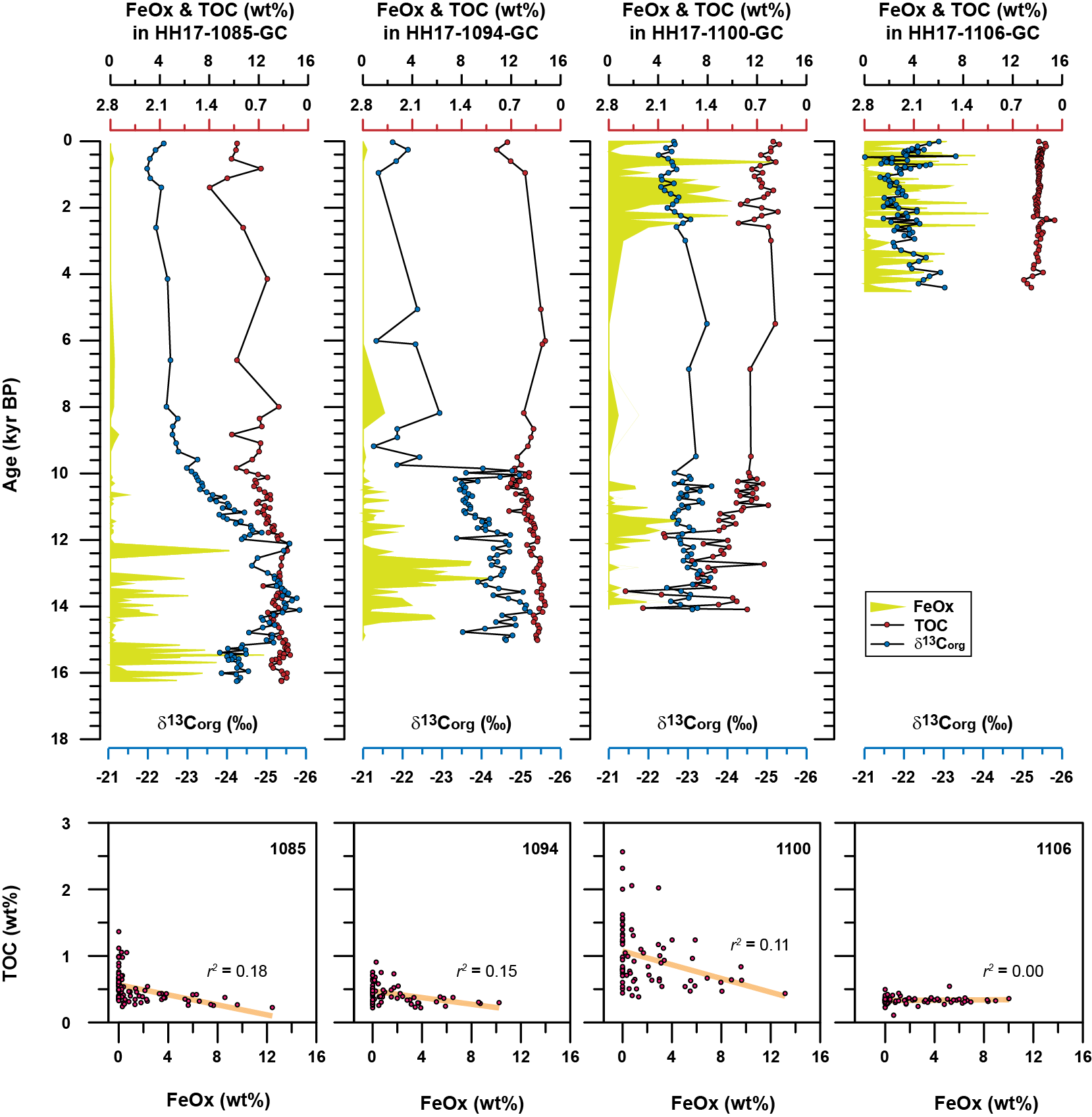
Supplementary Figure S1 to S3

Supplementary Table S1 to S10

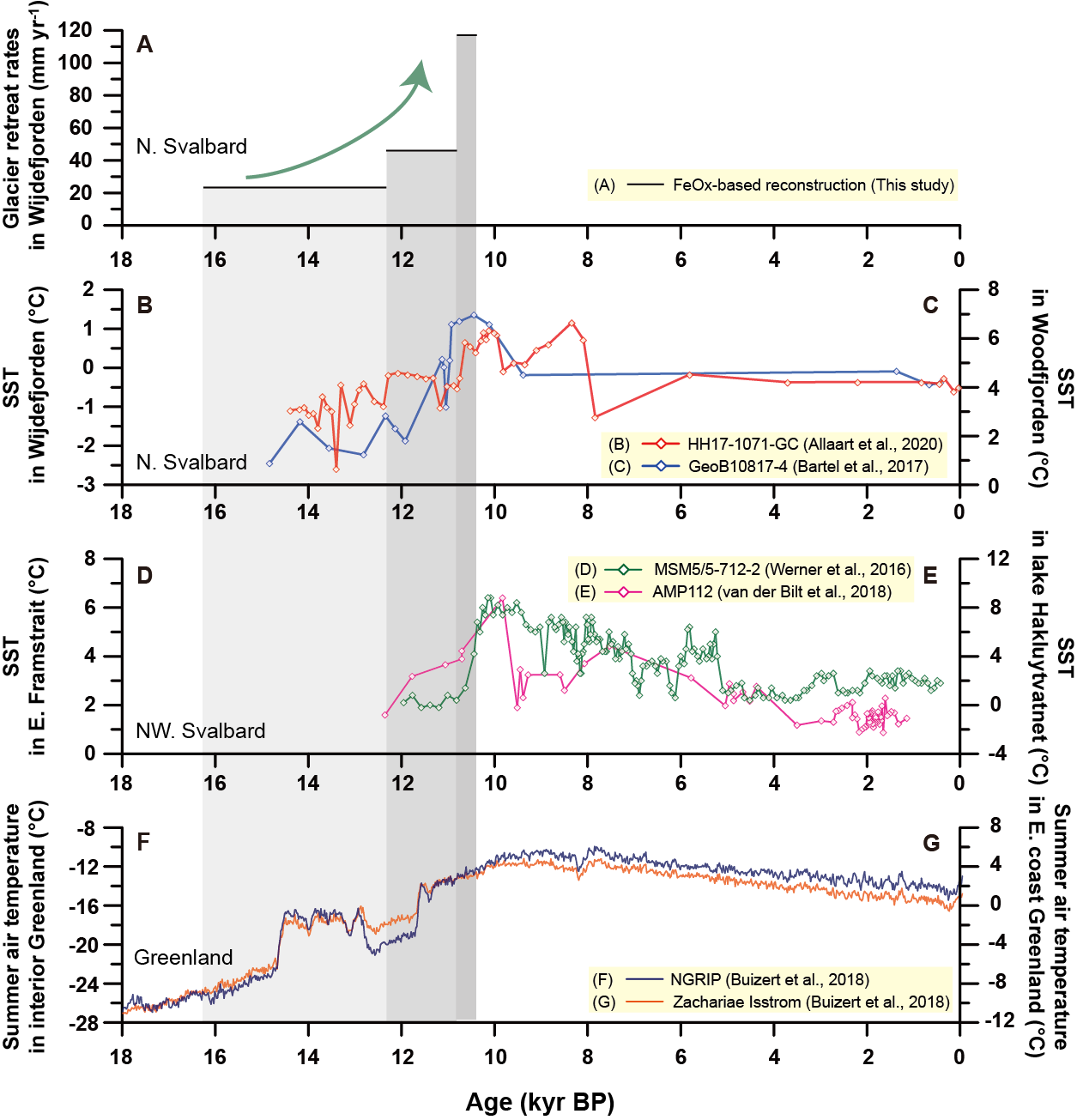
References



**Supplementary Fig. S1.** (A) Plots of Fe-(oxyhydr)oxide minerals (FeOx; weight percentage) versus distances from sampling sites closest to glacier termini (B) in four transect lines of Hornsund. The FeOx contents generally decrease with increasing distance from glacier termini.



**Supplementary Fig. S2. Comparison of Fe-(oxyhydr)oxides (FeOx) with total organic carbon (TOC) and its isotopes (δ13Corg) in cores HH17-1085-GC, HH17-1094-GC, HH17-1100-GC and HH17-1106-GC in Wijdefjorden.** There is no significant relationship between FeOx and TOC in all core sediments, implying a minor diagenetic influence on FeOx contents. The TOC and δ13Corg data in core HH17-1085-GC are from Jang et al. (2021).



**Supplementary Fig. S3. Comparison of glacier retreat rates in Wijdefjorden (A) with the various temperature records:** GDGTs-based seawater (sub)surface temperatures (SST) in Wijdefjorden (B), alkenone-based SST in Woodfjorden (C), SST derived from foraminiferal transfer function in eastern Framstrait (D), alkenone-based SST in lake Hakluytvatnet (E), and summer air surface temperatures in the interior (F) and eastern coast Greenland (G). All data are from the references in Figure (Allaart et al., 2020; Bartels et al., 2017; Buizert et al., 2018; van der Bilt et al., 2018; Werner et al., 2016).

**Supplementary Table S1.** Core information

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Station** | **Latitude (°N)** | **Longitude (°E)** | **Water depth (m)** | **Location** | **Recovery (cm)** |
| HH17-1085-GC∗ | 80.27 | 16.21 | 322 | Continental shelf off northern Svalbard | 465 |
| HH17-1094-GC | 79.74 | 15.42 | 148 | Wijdefjorden mouth | 377.6 |
| HH17-1100-GC | 79.30 | 15.78 | 112 | Inner fjord | 380.2 |
| HH17-1106-GC | 79.00 | 16.21 | 160 | Fjord head | 434 |

∗information from Jang et al. (2021)

**Supplementary Table S2.** AMS 14C ages and converted calendar ages of cores HH17-1094-GC, HH17-1100-GC and HH17-1106-GC

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GC station** | **Core depth (cm)** | **AMS 14C age (yr BP, 2σ)** | **Calendar Age (yr BP, 2σ)∗** | **Material dated** | **Reference** |
| HH17-1094-GC | 14.5 | 1488 ± 64 | 927±164 | Mollusc | This study |
| HH17-1094-GC | 24.5 | 6441 ±75 | 6808 ±197 | Mollusc | This study |
| HH17-1094-GC | 30 | 5740 ±30 | 6042 ±116 | Mollusc | This study |
| HH17-1094-GC | 35 | 8020 ±40 | 8390 ±105 | Mollusc | This study |
| HH17-1094-GC | 54.5 | 8620 ±30 | 9138 ±120 | Mollusc | This study |
| HH17-1094-GC | 55 | 9310 ±30 | 10015 ±138 | Mollusc | This study |
| HH17-1094-GC | 65 | 9220 ±30 | 9865 ±180 | Mollusc | This study |
| HH17-1094-GC | 215 | 10550 ±30 | 11563 ±244 | Mollusc | This study |
| HH17-1100-GC | 94 | 2470 ±30 | 1994 ±111 | Mollusc | This study |
| HH17-1100-GC | 120 | 2960 ±30 | 2604 ±121 | Mollusc | Braun (2019) |
| HH17-1100-GC | 150 | 9080 ±30 | 9644 ±124 | Mollusc | Braun (2019) |
| HH17-1100-GC | 154.5 | 9391 ±38 | 10110 ±118 | Mollusc | Braun (2019) |
| HH17-1100-GC | 225 | 10070 ±30 | 10935 ±164 | Mollusc | Braun (2019) |
| HH17-1106-GC | 14.5 | 820 ±30 | 363 ±83 | Mollusc | This study |
| HH17-1106-GC | 134.5 | 1290 ±30 | 737 ±84 | Mollusc | This study |
| HH17-1106-GC | 329.5 | 3140 ±30 | 2814 ±87 | Mollusc | This study |
| HH17-1106-GC | 424.5 | 4840 ±30 | 4983 ±143 | Mollusc | This study |

∗applying the Marine13 dataset of the Calib Rev. 7.0.4 program with △R = 105 ± 24 yr

**Supplementary Table S3**. (dataset.xlsx)

The contents of Fe-(oxyhydr)oxides (FeOx) in Svalbard bedrock.

**Supplementary Table S4**. (dataset.xlsx)

Spatial variability of Fe-(oxyhydr)oxides (FeOx) in Svalbard fjords.

**Supplementary Table S5**. (dataset.xlsx)

Temporal Fe-(oxyhydr)oxides (FeOx) variability in core HH17-1085-GC.

**Supplementary Table S6**. (dataset.xlsx)

Temporal Fe-(oxyhydr)oxides (FeOx) variability in core HH17-1094-GC.

**Supplementary Table S7**. (dataset.xlsx)

Temporal Fe-(oxyhydr)oxides (FeOx) variability in core HH17-1100-GC.

**Supplementary Table S8**. (dataset.xlsx)

Temporal Fe-(oxyhydr)oxides (FeOx) variability in core HH17-1106-GC.

**Supplementary Table S9**. (dataset.xlsx)

Total organic carbon (TOC) contents and its isotopes (δ13Corg) in bulk sediments from cores HH17-1094-GC, HH17-1100-GC and HH17-1106-GC

**Supplementary Table S10. Calculated glacier advance/retreat rates**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Observation** | **Age**  **(yr BP)** | **Age intervals**  **(yr)** | **Distance between**∗  **(m)** | **Advance/retreat rate**†  **(m/yr)** |
| Re-occurrence of FeOx at core HH17-1100-GC | 2,578 | 1,940 | 34,970 | <18.0 |
| First FeOx at core HH17-1106-GC | 4,519 | 5,864 |  |  |
| Last FeOx at HH17-core-1100 | 10,383 | 426  (24~825) | -49,600 | -116  (-60~-2060) |
| Last FeOx at core HH17-1094-GC | 10,809 | 1,514  (1055~1985) | -61,400 | -40.5  (-30.9~-58.2) |
| Last FeOx at core HH17-1085-GC | 12,324 | 3,929  (3341~4513) | -70,000 | -17.8  (-15.5~-21.0) |
| First FeOx at core HH17-1085-GC | 16,252 |  |  |  |
| Average glacier retreat rate |  | 5,846  (5336-6408) | -181,000 | -30.8  (-28.2~-33.9) |

∗assumed distance for the iron delivery to be 70,000 m

†95% confidential intervals within the parentheses

**References**

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